

REMARKS

A Petition and Fee for a Two-Month Extension of Time and an Excess Claim Fee Letter for four (4) excess independent claims are submitted herewith.

Claims 38-45, 54-64, and 75-81 are all the claims presently pending in the application. Claims 38-40, 42-45, and 55-64 are amended to more particularly define the invention. Claims 75-81 are added to claim additional features of the invention. Withdrawn claims 46-53 and 65-74 are canceled. Applicants reserve the right to file Divisional Applications. No new matter is added.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicants specifically state that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Applicants appreciate the Examiner's flexibility and accommodation in scheduling a Personal Interview for April 22, 2010 at 11 AM, during which Applicants met with Examiner Mandy C. Louie and her supervisor, Examiner Timothy Meeks. During the personal interview, Applicants asserted that claim 38 as currently amended would overcome the Hiramatsu reference. Specifically, Applicants asserted that Hiramatsu fails to teach or suggest a method for producing carbon nanowalls, including introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere.

The Examiner agreed and stated that it would be necessary to perform a new prior art search in view of claim 38 as currently amended.

Applicants also asserted that new claim 77 would overcome the Hiramatsu reference. Specifically, Applicants asserted that Hiramatsu fails to teach or suggest a method for producing carbon nanowalls, including creating a plasma atmosphere in at least one region of a reaction chamber by plasmatizing a source material including carbon, hydrogen, and fluorine as essential components.

The Examiner agreed and stated that it would be necessary to perform a new prior art search in view of the addition of new claim 77.

Applicants and the Examiner also discussed if one of ordinary skill in the art would combine the prior art references to teach or suggest the present invention. Applicants and the

Examiner further discussed steps to alleviate the Examiner's concerns with respect to claim 59 that prompted the issuance of a 35 U.S.C. § 112, second paragraph rejection.

In order to alleviate the Examiner's concerns with respect to the 35 U.S.C. § 112, second paragraph rejection of claim 59, we proposed amending claim 59 as is presently provided in the accompanying draft amendment. Specifically, referencing the original specification at pages 9 and 10, we exemplarily defined the invention of claim 59 and proposed new claim 78 for the Examiner.

Claim 59 stands rejected under 35 U.S.C. § 112, second paragraph as being allegedly indefinite. However, while Applicants respectfully disagree with this rejection, to expedite prosecution, claim 59 is amended to alleviate the Examiner's concerns and to render this rejection to be moot.

Claims 38-42, 44, 55, 57, and 60 stand rejected under 35 U.S.C. § 102(b) as being allegedly anticipated by Hiramatsu et al. (The 16th on Plasma Science for Materials: Fabrication of Carbon Nanowalls Using RF Plasma CVD, June 5, 2003).

Claims 43, 56, and 58 stand rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Hiramatsu in view of Nagasawa et al. (U.S. Patent Publication No. 2002/0072249 A1). Claims 45 and 64 stand rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Hiramatsu in view of Kirimura et al. (U.S. Patent No. 6,383,896 B1). Claim 59 stands rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Hiramatsu in view of Nagasawa, and further in view of Ravi et al. (U.S. Patent No. 6,548,313 B1). Claim 61 stands rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Hiramatsu in view of Kirimura, and further in view of Chang et al. (U.S. Patent No. 5,627,640). Claim 62 stands rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Hiramatsu in view of Nagasawa and Ravi, and further in view of Merkulov et al. (U.S. Patent No. 6,649,431 B2). Claim 63 stands rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Hiramatsu in view of Lee et al. (U.S. Patent No. 2002/0046953 A1).

The rejections are respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

An exemplary aspect of the claimed invention (e.g., as recited in claim 38) is directed to a method for producing carbon nanowalls, including creating a plasma atmosphere in a plasma-generating area which is at least one region of a reaction chamber by plasmatizing a source

material including carbon, introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere, and growing carbon nanowalls on a base material disposed in the reaction chamber.

Several conventional methods of forming carbon nanowalls have been developed. However, none of these conventional methods have been proven to possess high reproducibility or efficiency. (Application at pages 1-3).

An exemplary embodiment of the claimed invention, on the other hand, may include a method for producing carbon nanowalls, including introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere. (Application at page 37, line 16 to page 41, line 5 and Figures 2, 3, and 5). This exemplary feature may provide a method for producing carbon nanowalls, where carbon nanowalls can be produced with high reproducibility and efficiency.

II. THE PRIOR ART REJECTIONS

A. The Hiramatsu Reference

Hiramatsu discloses the fabrication of carbon nanowalls (Hiramatsu at Abstract). The Examiner alleges that Hiramatsu anticipates the claimed invention. Applicants respectfully disagree.

For example, Hiramatsu fails to teach or suggest a method for producing carbon nanowalls, “comprising . . . introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere”, as recited, for example, in claim 38. (Application at page 37, line 16 to page 41, line 5 and Figures 2, 3, and 5). As previously mentioned, this exemplary feature may provide a method for producing carbon nanowalls, where carbon nanowalls can be produced with high reproducibility and efficiency.

Hiramatsu teaches that H radicals are generated outside the reaction chamber plasmatizing a source gas. However, Hiramatsu fails to teach or suggest a method for producing carbon nanowalls, including introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere, where the radicals are introduced in a

direction perpendicular to a surface of the base material. Indeed, Hiramatsu teaches that H radicals are generated outside the reaction chamber and introduced in a direction parallel to a surface of a substrate.

In the present invention, a method for producing carbon nanowalls includes introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere, where the radicals are introduced in a direction perpendicular to a surface of the base material. Therefore, the density of the radicals applied to the substrate of an exemplary aspect of the claimed invention may be uniform. This exemplary aspect of the claimed invention may allow carbon nanowalls to be uniformly formed on the substrate.

In Hiramatsu, the H radicals are introduced in a direction parallel to the surface of the substrate so that the density of the H radicals applied to the substrate cannot be uniform. Therefore, carbon nanowalls cannot be uniformly formed on the substrate.

In Hiramatsu, inactive H particles changed from radicals, that is, radicals that are eliminated, are more likely to be introduced in the reaction chamber because the H radicals are generated outside the reaction chamber. In an exemplary aspect of the present invention, active radicals may be introduced in the source gas plasmatizing area because the radicals may be generated just above the source gas plasmatizing area.

The claimed invention provides unexpected effects and cannot be easily anticipated by Hiramatsu. In addition, during the personal interview conducted on April 22, 2010, the Examiner admitted that Hiramatsu failed to teach or suggest the above-referenced exemplary feature of the claimed invention.

Therefore, Applicants respectfully request the Examiner to reconsider and withdraw this rejection.

B. The Nagasawa, Kirimura, Ravi, Chang, Merkulov, and Lee References

To make up for the deficiencies in Hiramatsu, the Examiner applies at least one of Nagasawa and Kirimura. The Examiner also applies at least one of Ravi, Chang, Merkulov, and Less to make up for respective deficiencies in the alleged Hiramatsu and Nagasawa combination and the alleged Hiramatsu and Kirimura combination.

However, even assuming (arguendo) that one of ordinary skill in the art would combine Hiramatsu with the applied prior art references, the resultant combinations fail to teach or suggest

each feature of the claimed invention. Specifically, whether applied alone or in combination, all of the applied prior art references, including Hiramatsu, fail to teach or suggest a method for producing carbon nanowalls, “comprising . . . introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere”, as recited, for example, in claim 38. (Application at page 37, line 16 to page 41, line 5 and Figures 2, 3, and 5).

Nagasawa discloses a method of forming silicon carbide of uniform thickness and density on a Si substrate surface. However, carbon nanowalls are not a film of uniform thickness and have a particular nanostructure. Therefore, whether carbon nanowalls having a particular structure can be grown by using the gas used to form a uniform thick film of silicon carbide cannot be anticipated. Therefore, in Nagasawa, there is no motivation to use the gas for forming a uniform thick film disclosed by Nagasawa to form carbon nanowalls in Hiramatsu.

Kirimura also discloses a method for forming a silicon based film with a uniform thickness on a substrate. However, Kirimura does not teach or suggest at all that carbon nanowalls having a particular nanostructure are formed. Indeed, forming a film of uniform density has no relevance to producing the carbon nanowalls of the claimed invention. The method for forming a uniform thick film cannot be diverted.

Therefore, neither Nagasawa nor Kirimura, even assuming (arguendo) combination with Hiramatsu, teach or suggest a method for producing carbon nanowalls, including introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere.

Ravi discloses a method of transforming an amorphous carbon film into a carbon nano tube. Ravi also discloses an integrated circuit using the carbon nano tube. Merkulov discloses a method of forming carbon tips. Chang discloses a method for measuring radical species distribution in plasma. Lee discloses a method of forming carbon nano tubes/fibers.

However, none of the prior art references, even assuming (arguendo) combination, teach or suggest a method for producing carbon nanowalls, including introducing radicals generated by decomposing a radical source in a radical-generating area, which is disposed in the reaction chamber and is located outside the plasma-generating area, into the plasma atmosphere. Thus, the Examiner fails to make a *prima facie* case of obviousness.

In addition, it is particularly emphasized that one of ordinary skill in the art would not have combined the aforementioned references with Hiramatsu because of the clear distinction between nanowalls and other nanoparticulate structures. In addition, during the personal interview conducted on April 22, 2010, even the Examiner admitted that definite differences existed between nanotubes and nanowalls as supported in the original specification.

Therefore, Applicants respectfully request the Examiner to reconsider and withdraw this rejection.

III. NEW CLAIMS

New claims 75-81 are added to claim additional features of the invention and to provide more varied protection for the claimed invention. These claims are independently patentable because of the novel and nonobvious features recited therein.

Applicants submit that the new claims are clearly patentable over the cited prior art references at least for analogous reasons to those set forth above.

With respect to claims 75 and 77, carbon nanowalls are not mere carbon films. They are substances having a special nanostructure. As such, Hiramatsu does not teach or suggest that CH₄, CF₄, and CHF₃ are source materials. When carbon nanowalls are grown by plasmatizing, configurations of the carbon nanowalls depend on the types of the gases used. An exemplary aspect of the invention (supported in the specification from line 6 on page 9 to the second line from the bottom of page 11) includes creating a plasma atmosphere in at least one region of a reaction chamber by plasmatizing a source material which includes at least one compound selected from the group consisting of CH₄, CF₄, and CHF₃. An exemplary aspect of the invention also includes creating a plasma atmosphere in at least one region of a reaction chamber by plasmatizing a source material including carbon, hydrogen, and fluorine as essential components.

In other words, an exemplary embodiment of the invention is found only through the experiments which gas is useful in producing carbon nanowalls having good configurations. The inventors have discovered that CH₄, CF₄, and CHF₃ gas can be used in an exemplary aspect of the invention by generating H radicals in the area other than the source gas plasmatizing area and introducing the H radicals in the source gas plasmatizing area.

Therefore, whether carbon nanowalls having a good quality can be grown by using CH₄, CF₄, and CHF₃ gas cannot be anticipated from C₂F₆ gas taught by Hiramatsu.

Further, with respect to claims 76 and 78, Hiramatsu does not teach or suggest growing carbon nanowalls on a base material disposed in the reaction chamber by varying a ratio of a feed rate of the source material further including fluorine to a feed rate of the source material further including hydrogen. This is exemplarily described on lines 13 to 22 on page 11 in the specification of the present application. Hiramatsu teaches only a gas of C₂F₆, and does not suggest a mixture gas with other source gases at all. Therefore, the invention of claims 76 and 78 cannot be anticipated by Hiramatsu.

Moreover, with respect to claim 79, Hiramatsu does not explicitly teach or suggest introducing hydrogen radicals into the plasma atmosphere, the hydrogen radicals not including OH radicals or O radicals and being generated outside the plasma atmosphere. If there are neither OH radicals nor O radicals, carbon nanowalls can be grown. If there are OH radicals or O radicals, carbon nanowalls cannot be grown. This is exemplarily described on the seventh to third lines from the bottom of page 8. Hiramatsu does not suggest the effects of OH radicals and O radicals on the growth of carbon nanowalls at all. Therefore, the invention of claim 79 cannot be anticipated by Hiramatsu.

Additionally, with respect to claim 80, the inventors are the first to discover that the carbon nanowalls are oriented by tilting a line normal to the base material with respect to a direction of an electric field. This is clearly described from the second line from the bottom of page 11 to line 17 on page 12. In Hiramatsu, the direction of the electric field is parallel to the line normal to the substrate. Therefore, Hiramatsu does not teach or suggest that the longitudinal direction of the carbon nanowalls (the direction parallel to the surface of the substrate) is oriented in the direction of the electric field. Consequently, the invention of claim 80 cannot be anticipated by Hiramatsu.

Finally, with respect to claim 81, the inventors are the first to discover pretreating the base material by applying the radicals to the base material without plasmatizing the source material before the growing of the carbon nanowalls. This is described from line 17 on page 12 to line 3 on page 13 of the specification. Hiramatsu does not teach or suggest that the H radicals are applied to the surface of the substrate before carbon nanowalls are grown. Therefore, the invention of claim 81 cannot be anticipated by Hiramatsu.

IV. FORMAL MATTERS AND CONCLUSION

It is noted that, on the cover page of the Office Action dated November 25, 2009, Hiroyuki Kano is listed as the "First Named Inventor". However, Hiroyuki Kano is not an inventor in this Application. Indeed, a Supplemental Executed Declaration was filed on January 22, 2007 replacing the erroneous Declaration filed on May 5, 2006 that included Hiroyuki Kano as an inventor.

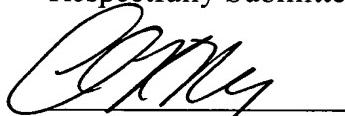
For some reason, when a corrected filing receipt was issued on April 24, 2009, Hiroyuki Kano's name was included as an inventor, when it was previously and correctly removed from the filing receipt. Further, no response has been received from the Second Request for Corrected Official Filing Receipt filed on May 29, 2009. Therefore, Applicants respectfully make a third request for a Corrected Official Filing Receipt that does not include Hiroyuki Kano as being an inventor of this Application.

In view of the foregoing, Applicants submit that claims 38-45, 54-64, and 75-81, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,



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